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OBSERVATIONS ON *RHYNCHOSPORIUM SECALIS* (OUD.) DAVIS, LEAF BLOTCH OF BARLEY AND RYE

BY

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FROM THE NEW PHYTOLOGIST, VOL. XXVII, NO. 4, 30 NOVEMBER, 1928.

WHELDON AND WESLEY, LTD.
2, 3 AND 4, ARTHUR STREET, NEW OXFORD STREET
LONDON, W.C. 2

PRINTED IN GREAT BRITAIN

[From THE NEW PHYTOLOGIST, Vol. XXVII, No. 4,
30 November, 1928.]

OBSERVATIONS ON *RHYNCHOSPORIUM SECALIS* (OUD.) DAVIS, LEAF BLOTCH OF BARLEY AND RYE

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(With Plate V, and 3 figures in the text.)

The occurrence of *Rhynchosporium Secalis* in Britain was first recorded in 1919 by Cotton (1), who stated that it had been found on rye in Devon and Cornwall. Since then the present writer has had this fungus constantly under observation in the neighbourhood of Cambridge, where it occurs frequently on barley and to a lesser extent on rye. As it was considered likely at one time that the fungus might prove destructive to certain new hybrid barleys produced on the University Farm, an investigation of the disease caused by it was undertaken.

The fungus was first described in 1897 by Oudemans (2) in Holland under the name *Marsonia Secalis* Oud., and in the same year Frank (3) referred briefly to a disease of rye and barley in Germany caused by the same fungus. The name was changed later to *Marssonina Secalis* (Oud.) Magnus. In 1900 Heinsen (4) in Germany transferred the fungus to the new genus *Rhynchosporium* because of the peculiar beaked, once-septate spores, and named it *Rhynchosporium graminicola* Heinsen. Lastly, Davis (5) in the United States named it *Rhynchosporium Secalis* (Oud.) Davis, in accordance with the International Rules of Nomenclature, and it is by this name that the fungus is now generally known.

In addition to its presence in Holland, Germany, the United States and Britain *R. Secalis* has been recorded in Canada by Drayton (6), and in New South Wales (7), where several types of fodder barleys have proved resistant to it. The disease, although most prevalent on barley and rye, has been seen sparingly by Heinsen (4) on wheat in Germany, and on a considerable number of wild grasses, including *Dactylis glomerata*, *Agropyrum repens* and *Bromus inermis*, in various countries. Apart from an attack on rye seen by Heinsen (4) and a statement by Drayton (6) that the disease is serious in the

Mississippi Valley, no considerable damage to crops has been attributed to this fungus. In California it is stated(8) that *R. Secalis* attacks barley, especially early sown varieties, soon after germination in the autumn, but that some varieties are resistant to attack.

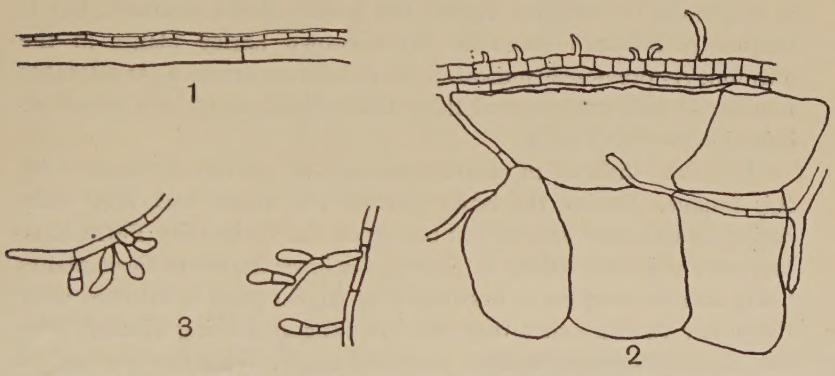
In the neighbourhood of Cambridge *R. Secalis* has been found by the writer and by Professor N. J. G. Smith on *Bromus sterilis*, *B. mollis* and *Dactylis glomerata*, as well as upon barley and rye.

Around Cambridge the disease is most common on barley during the latter part of the winter and early spring, especially when winter-sown. It is also abundant on self-sown barley plants during the autumn. During early spring some new hybrid barleys on the University Farm have been severely affected, but when active growth commences at a later stage the plants grow away from the disease, and the foliage subsequently formed is almost free from attack.

R. Secalis affects any part of the leaves, producing spots or blotches of irregular shape (Pl. V, figs. 1 and 2). On barley the auricles are commonly attacked, perhaps because of the tendency for water to be held in this region. The blotches first appear as water-soaked areas, which become greyish in the centre with a brown margin. The blotches often coalesce and entire leaves may be destroyed by the fungus. The greyish colour in the middle of a blotch is due to the formation of spores, which are produced over nearly the whole area and lie on the surface at maturity. Spores may be formed on both surfaces of the leaves.

The spores are typically two-celled and markedly beaked, as described by Heinsen(4). In my experience spores from barley leaves measure 11–16 × 3·5–5μ. According to Heinsen(4), in the process of spore formation, hyphae become entangled together under the cuticle and give rise to short branches which penetrate it and form spores, but he gives no figure of the process of spore formation on the leaves. The illustrations of spore formation given by him concern this process in cultures. Hand sections through the blotches showed that Heinsen's description of the mode of spore formation on the leaves was incomplete, so material was fixed and microtomed in order to make out the exact method of spore formation. As a preliminary to spore formation certain hyphae penetrate the epidermis from the mesophyll and arrange themselves, partly under the cuticle (Text-fig. 1) and partly in the epidermal cells, so that they lie parallel with the surface of the leaf. These hyphae become divided up by transverse septa into small, regular cells (Text-figs. 1 and 2). These cells then put out small protuberances

by a process of budding, which rupture the cuticle (Text-fig. 2). The protuberances become curved and once-septate, and at maturity are separated off from the parent cells as spores. This mode of spore formation is very peculiar and the writer knows of no other parasitic fungus in which it occurs. From this description it can be readily understood why the whole of the central region of the blotch appears to be covered with spores. Davis (5) states that the mode of spore formation in *R. Secalis* is the same as in *R. Alismatis* (Oud.) Davis, where undifferentiated hyphae make their way to the stomata and bear conidia at their extremities. The present writer has not seen conidiophores of this fungus in the stomata and there is no doubt that the great majority of the spores, if not all of them, are formed in the peculiar manner described above.



Text-fig. 1. Mycelium of *Rhynchosporium Secalis* under cuticle of barley leaf. ×350.

Text-fig. 2. Mycelium of *Rhynchosporium Secalis* in barley leaf showing spore formation (the cuticle has broken away). ×450.

Text-fig. 3. Spore formation of *Rhynchosporium Secalis* in a hanging-drop culture on Dox's agar. ×350.

The spores germinate readily in water, each cell putting forth one or more germ tubes. In hanging-drop cultures on Dox's medium or barley-extract agar the germ tubes form a sparse mycelium which quickly gives rise to spores from unspecialised cells, as indicated in Text-fig. 3. In cultures the spores are curved or straight, mostly uniseptate, but occasionally 2 to 3-septate. No indication of a yeast-like mode of development as described by Heinsen (4) was observed in the writer's cultures. The fungus does not grow well on agar media In plate cultures the colonies are of strictly limited growth (Pl. V, fig. 3); at first they are greyish in colour, but become brownish with age; spores are produced on the surface of the colonies, the mode of

formation being the same as in hanging-drop cultures, and as described by Heinsen (4). On the other hand the fungus grows well on barley leaves sterilised by heat, and spores are formed freely on them.

Inoculation experiments carried out during the winter showed that infection of unwounded barley leaves could be brought about by placing an emulsion of the spores in water on either surface of the leaf. Heinsen (4) also successfully reproduced the disease by inoculation.

No other spore stage than that described has been observed in the life-history of this fungus. Heinsen (4) states that the fungus possesses some capacity for survival in the soil, but no evidence for this has been observed by the writer. There is no difficulty in understanding how the fungus survives from season to season. The fungus is not much in evidence during the height of the summer, but it frequently becomes abundant on self-sown barley plants in the autumn. As previously indicated, *R. Secalis* occurs on a considerable number of wild grasses, and these undoubtedly may be a source of infection to crop plants.

It is very difficult to estimate the amount of damage caused by this fungus. During the latter part of the winter and very early spring certain new varieties of barley on the University Farm have been seriously affected by *R. Secalis*, the lower leaves of these plants being almost completely destroyed by it. So gravely affected were these new varieties that they were in danger of being discarded by the plant breeders who had produced them. With the renewal of active growth in April and May even the most severely affected types recovered to such an extent that at harvest time little difference could be discerned between them and varieties which had been only slightly attacked. The loss of foliage, however, must have had some weakening effect on the plants.

I am indebted to Professor N. J. G. Smith and Mr W. C. Moore for references.

Summary

1. Leaf Blotch of barley and rye, caused by *Rhynchosporium Secalis*, is of common occurrence in the vicinity of Cambridge, being most frequently seen in late winter and early spring. The fungus occurs also on various wild grasses.

2. The disease is characterised by blotches of irregular shape on the leaves. At maturity these discoloured areas are greyish with a brown margin.

Fig. 1

Fig. 2

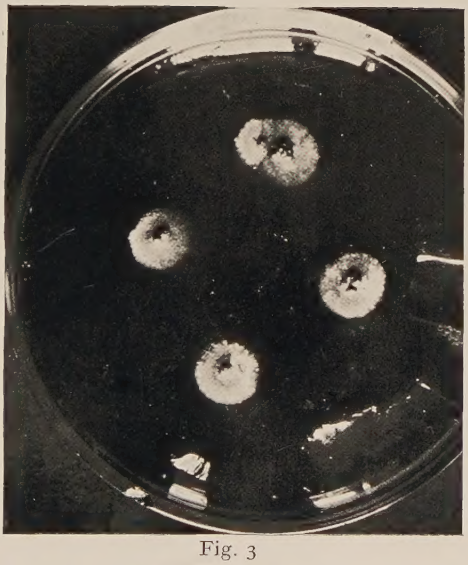


Fig. 3

Fig. 1. Blotches on barley leaves caused by *Rhynchosporium Secalis* (nat. size).
Fig. 2. Blotches on barley leaves caused by *Rhynchosporium Secalis*: older stage, at the time of spore formation ($\frac{2}{3}$ nat. size).
Fig. 3. Colonies of *Rhynchosporium Secalis* on barley-extract agar ($\frac{2}{3}$ nat. size).

3. It is unlikely that serious damage will be caused by this fungus under English conditions as even the most susceptible types of barley grow away from the disease when active growth commences in the spring, the later formed leaves being almost free from infection.

4. The peculiar method of spore formation of *R. Secalis* on the host is described. Profusely septate hyphae arrange themselves under the cuticle and in the epidermal cells, parallel with the surface of the leaf. The cells of these hyphae bud forth protuberances which disintegrate the cuticle and become exposed as spores. The method of spore formation differs considerably from the accounts of this process given by Heinsen (4) and Davis (5).

5. Inoculation experiments show that both surfaces of the leaf can be infected by this fungus without wounding.

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THE NEW PHYTOLOGIST

A BRITISH BOTANICAL JOURNAL

EDITED BY

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